**Projects #4 and #5 (Final), Due July 26 if you want to avoid an incomplete.**

This project is to help you explore various advanced aspects of simulation and output analysis. This is all using a 1 server queue.

For any arrival create a linear congruential generator for your random number generator. Let the prime numbers a=100801, c=103319 and m=193723. As a starting seed, use 50,001 for the arrivals. All simulations should start this way.

For any service time create a congruential generator for your random number generator. Let the prime numbers a=7,000,313 and m=9,004,091. As a starting seed, use 94,907. All simulations should start this way.

1. Create an M/M/1 with a arrival rate of exponential with an arrival rate of 1/3 per hour and a service rate of ½ per hour.

Run this for 30 replications each for 500 hours. You can either do this for utilization or expected number of people in line. Your choice.

1. Perform a t-Test to determine whether or not there is a statistical difference between the simulated data and the expected value. Also find the confidence interval.
2. Repeat this entire process for 40 repetitions (1200 runs) and find all 95% confidence intervals. Determine how many of these 95% confidence intervals do not contain the theoretical mean.
3. Redo part a and b, but give yourself 100 hours of warm up.
4. Run a batch means by running the simulation for 15,000 hours and divide the data into 500 hours. Compare the difference between a and d.
5. Run antithetic pairing on part a and compare confidence intervals and standard deviation to determine if there is variance reduction.
6. Run this simulation for 1000 regenerative cycles and report the average time and confidence interval of the length of the regenerative cycle.
7. Create a G/G/1 queue with an arrival distribution of 3/64 x2 between 0 and 4 and 0 else.

Run this for 30 replications each for 500 hours. You can either do this for utilization or expected number of people in line. Note it’s mean is 3. Let the service distribution be a normal (2,.25). You need to generate these and cannot have software generate them for you.

1. Use seeds 50001 for arrivals and 94907 for service times. Perform a t-Test to determine whether or not there is a statistical difference between the simulated data and 1 a. Also find the confidence interval.
2. Repeat this entire process for 40 repetitions and find all 95% confidence intervals. Determine how many of these 95% confidence intervals do not contain the theoretical mean from part 1. Observe that both 1 and 2 have the same average performance.
3. Use CRN as a VRT (revert to previous seeds). Compare the variances between 1a and 2a to determine if there is variance reduction.
4. Run this simulation for 1000 regenerative cycles and report the average time and confidence interval of the regenerative cycle.
5. Compare both 1 and 2 and determine the variances of all distributions. Comment on the importance of the variance in the simulations.

Report all of this in a technical report. No Executive summary.

**Project #5 (Capstone project)**

Simulate any real world system. This system must be more than a single queue. Report anything that you think is important and draw any relevant conclusions including improvements to the system, if possible. Consider the executive summary written to the owner of the business and the technical report written to an IE in the business. This assignment must include at least one hour of collecting real data.

Your goal is to show your mastery of simulation in the real world. The number of replications, type of statistics used and reported are completely up to you. Things that I expect to see. (This is what I believe a good simulation project should have.)

A problem description (This part needs to have much more detail than normal because I

have not seen the problem first hand.)

How data was collected.

How you determined the distributions.

A description of why your model is appropriate

Whether or not your model is statistically different than the real world.

How you tried to improve the system.

Whether or not your improvements are statistically different than original simulation.

Recommendation

An executive summary and technical report are required. A 90% or more means both the CEO and IE would agree with your recommendation.